Preprint
UCRL-JC-137525

Milling and Blending of Ceramic Powders for the Plutonium Immobilization Program

D. T. Herman, W. E. Biehl

This article was submitted to
American Nuclear Society 2000 Annual Meeting and Embedded Topical Meetings
San Diego, CA
June 4-8, 2000

February 14, 2000

U.S. Department of Energy
Lawrence Livermore National Laboratory

DISCLAIMER

Milling and Blending of Ceramic Powders for the Plutonium Immobilization Program

D. T. Herman
Westinghouse Savannah River Company

W. E. Biehl
Lawrence Livermore National Lab

The goal of the Plutonium Immobilization Program is the immobilization of surplus weapons usable plutonium in a ceramic form. The ceramic will then be encapsulated in high level waste glass using the can-in-can configuration. In the ceramic line of the immobilization plant, surplus plutonium oxide of less than 100 micron particle size will be received for immobilization. The plutonium oxide must be sized reduced and intimately blended with uranium oxide and the other ceramic forming materials containing neutron poisons to allow for complete interaction during sintering. Once properly blended, the formulation will be pressed into the desired ceramic form and then sintered to produce the targeted mineral phases. The equipment of choice for the size reduction of the actinides and the blending with the precursor materials is the Union Process attritor mill.

The attritor mill is best described as a stirred ball mill and consists of a stationary tank filled with grinding media that is agitated by a shaft with stirring arms. The rotational shaft stirs the media at high-speed causing shearing and impact forces on the material resulting in size reduction and dispersion. Speeds over 1000 rpm can be reached by the stirring shaft. The high-speed of the attritor mill imparts a large amount of energy to the feed powder. This high energy dramatically reduces the time required to mill/blend from hours to minutes. Another advantage of the equipment is that operations are performed completely dry.

Powder is discharged from the attritor by opening a discharge valve containing a slotted screen. A picture of the attritor mill is given as Figure I.

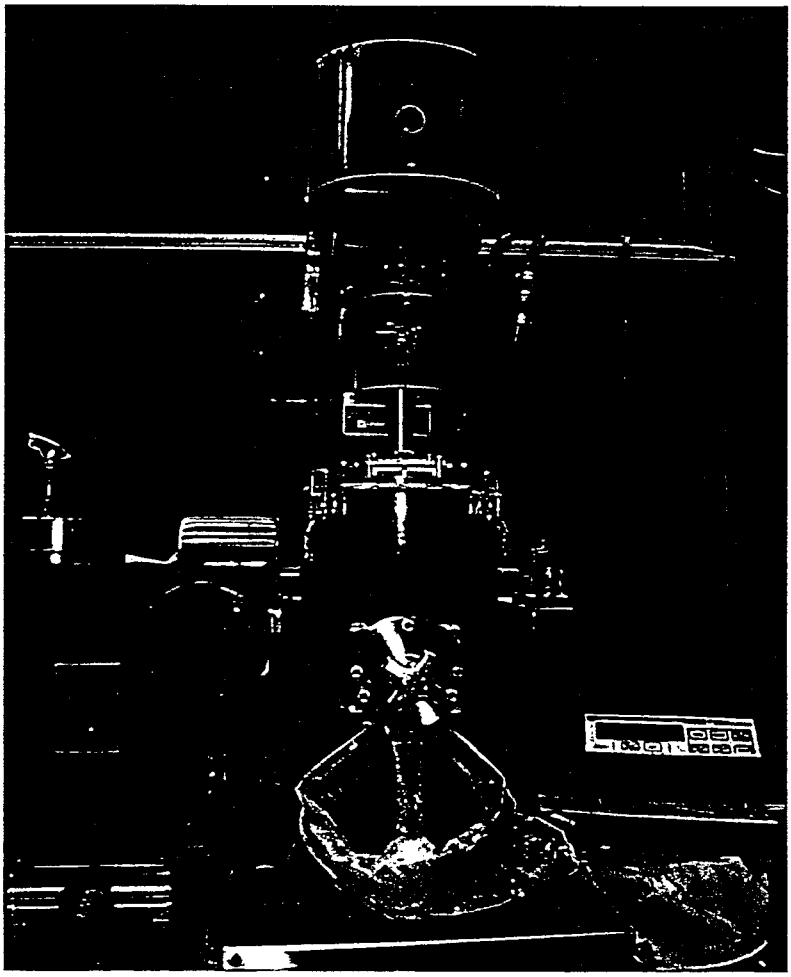

Figure 1. Model HSA-1 Attritor Mill

Process and equipment tests have been run using cerium as a chemical substitute for the actinides. Substitution of cerium oxide allows the proper ceramic phases to form during sintering. Though cerium is a good chemical surrogate for the actinides, it does not provide an adequate surrogate to represent the physical properties of the actinide oxides. Therefore, manganese oxide has been used for a grinding surrogate. Manganese oxide was used since it has the same structure and approximately the same hardness.

Surrogates were used to determine operational parameters. All parameter were then confirmed using uranium oxide. Several tests have been performed to test the size reduction and micro-scale blending parameters. The blended powders were pressed into pucks and sintered. The sintered pellets were then sectioned and analyzed to determine if the proper phases formed and that all the material reacted.

In addition to puck analysis, processed powder was analyzed using an optical microscope and Scanning Electron Microscopy. Results to date have shown that the discharge from the mill is in the form of small aggregates of approximately 10 microns, with the individual particles being much smaller in size. The aggregates are a blend of all materials; thus, the separation of the actinide materials from the neutron poisons is prevented. A sample of powder is shown in Figure 2.

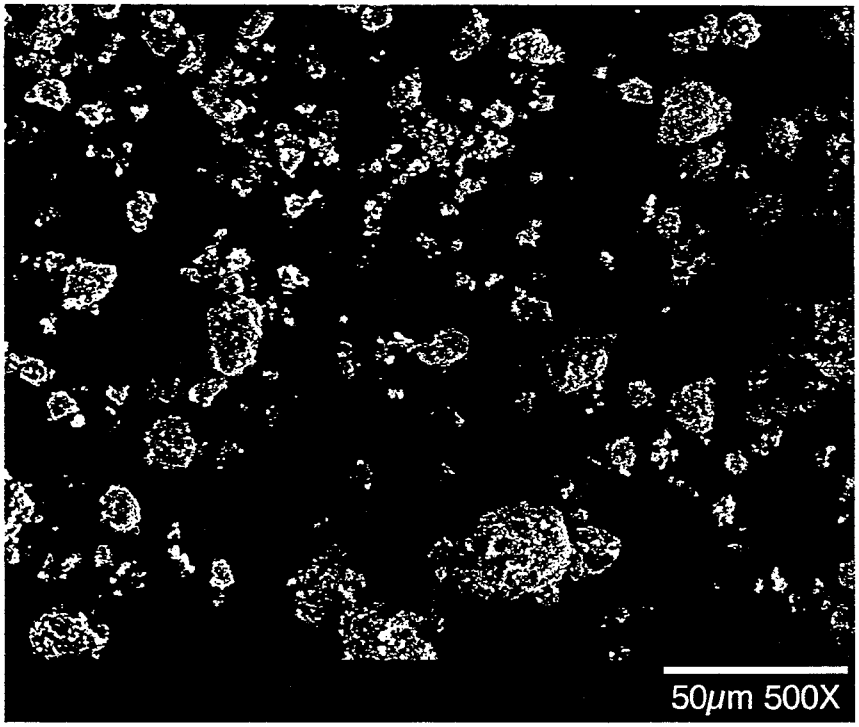

Figure 2. Powder Sample After Blending

Results of all testing have confirmed that the attritor mill has met all goals of size reducing and micro blending materials. Surrogate and powders using uranium formed the proper phases and completely reacted during sintering. Work will continue in order to scale up the milling and blending operations for plant and to refine the plant operating limits.

This work was performed under the auspices of the U.S. Department of Energy by the University of California, Lawrence Livermore National Laboratory under Contract No. W-7405-Eng-48.